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SURGERY.

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21



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perience, to consider the results obtained, and to answer sundry criticisms, undoubtedly due to a total misunderstanding of the principles involved in the method and mode of application of the remedy.

Since the commencement of the practice under consideration in August, 1879, in many operations, both capital and minor, in hospital as well as in private practice, and frequently with the most unhygienic surroundings, there has been observed, except in one case, an absolute exemption from sepsis in any form. This case will be considered further on.

The method of treatment of operation wounds by hot water is based upon the following propositions :

1. After the larger vessels have been tied in an operation wound there occurs an outward flow from the divided arterioles, venules, and lymph-spaces of a sero-sanguineous fluid, highly albuminous in its character, in varying quantity, and continuing for a longer or shorter period.

2. As long as this outward flow continues there is a perfect immunity from infection by atmospheric germs.

3. The application of hot water checks this outward flow, coagulates the albuminous elements in the fluid, and forms an impenetrable shield over the surface of the wound.

4. Hot water applied to the abraded surface acts as a powerful cardiac stimulant and controls shock.

In order to test the temperature necessary to produce coagulation of albumin contained in serum, the following experiment was made :

A test-tube was partly filled with serum, and a thermometer so arranged that the bulb was immersed beneath the surface of the fluid. The test-tube was immersed in water and heat applied. At  $68^{\circ}\text{C.}$  ( $= 154^{\circ}\text{F.}$ ) the serum, at first bright red, became darker and partially coagulated,

and at  $70^{\circ}\text{C.}$  ( $= 158^{\circ}\text{F.}$ ) it assumed a grayish, muddy appearance, and was completely coagulated. It was observed that the temperature of the water in which the test-tube was immersed exceeded that of the contents of the test-tube by about  $14^{\circ}\text{C.}$ , or  $57^{\circ}\text{F.}$  In the first instance the hot water employed stood at  $179.6^{\circ}\text{F.}$ , and in the latter at  $183.2^{\circ}\text{F.}$  Or, in other words, it is necessary that the water should have a temperature of not less than  $183^{\circ}\text{F.}$  in order that firm coagulation may result. At  $200^{\circ}\text{F.}$  to  $212^{\circ}\text{F.}$  it will blister if applied to the skin, and, if a sufficiently prolonged application is made, will *cook* the abraded surface, or, in other words, coagulate the albuminous elements in the superficial capillaries, and still further increase the protective power afforded by the method.

I am in the habit of using water slightly below the boiling point, or at the only diminution of temperature it would suffer during the time occupied in transit from the fire to the operating-room.

It seems to me evident that, owing to the greater vitality of the deeper seated muscular tissues, they possess much greater powers of resistance to the effect of heat than the skin. In making the application, this fact should be recognized, and care taken to prevent the water running beyond the abraded surface and blistering the surrounding integument, as I have seen occur in several instances owing to carelessness of the one making the application. *The application should be continued until ALL OOZING is stopped, the parts are thoroughly GLAZED, and the red hue of the tissues is decidedly deadened.*

The secretions which take place from operation wounds treated by this method are usually of a clear or slightly opaque serum, and which, after thirty-six or forty-eight hours, may contain flocculi of coagulated albumin in a greater or less quantity, governed by the intensity of the

application and the amount of the previous oozing. This appearance of albuminous flocculi is more especially observed in cases in which the wound is closed and treated by through-drainage. In open wounds the albuminous deposit is more appreciable to the eye, resembling in some cases the exudation of diphtheria. This exudation in the course of a few days is thrown off, leaving a healthy granulating surface beneath.

The immunity from septic absorption which is afforded to patients who may have undergone capital operations under the most unsanitary surroundings is well illustrated by the case of Thomas G., who was admitted to the Jersey City Hospital, July 18, 1883, for lacerated wound of the foot, and who underwent amputation of the leg at its lower third, and that of Adam H., who was admitted to the same hospital, July 23, 1883, for compound comminuted fracture of the leg, followed by amputation of the thigh at the lower third. Both were the result of railroad injuries. G. and H. were both discharged, cured, September 3, 1883.

The point of interest lies in the fact that there were in the hospital at the time, in the same ward, several cases of erysipelas and a large number of chronic abscesses, and in the female wards immediately overhead four cases of puerperal fever. At no time during the progress of treatment was there observed the slightest untoward symptom. As a promoter of reaction, cases are constantly occurring which illustrate the power of hot water as a cardiac stimulant when applied to the abraded surface of an operation wound.

In a case of hysterectomy performed by Dr. Nathan Bozeman, in which the symptoms of shock were urgent, I injected into the peritoneal cavity water at 120° F., with an immediate arrest of collapse, and rapid and complete reaction.



In a case of suppurative peritonitis due to perforation of the appendix vermiformis, for which I performed laparotomy in June, 1886, I injected water at the same temperature as in the preceding case, thoroughly washing out the cavity of the abscess. The patient recovered, although he was bordering on collapse at the time of the operation.

In the "Medical Record," March 19, 1887, Dr. W. Gill Wylie reports a case of laparotomy in which he used water at 105° to 110° F. for the relief of shock and arrest of hæmorrhage, with immediate relief of the symptoms. After describing the operation, he uses the following language: "I noticed that not only was the bleeding checked by the hot water, but the indications of shock, which were present to an alarming extent—that is, feeble heart's action, cold perspiration, etc.—were at once relieved by the hot water. . . . The result was magical. After this the symptoms of shock did not return, and at no time was there a subnormal temperature."

These statements of Dr. Gill Wylie are, I believe, absolutely true, as I have during the past eight years demonstrated time and time again; in fact, so frequently as to lose all novelty to those who are in the habit of witnessing operations in St. Francis Hospital.

When, however, the astonishing discovery is made, in 1887, that hot water will arrest oozing, and that hot water will promote reaction and relieve shock, we are forced to the conclusion that a portion of the medical periodical literature of the day has been overlooked by the gentleman. I can not bring myself to believe that he would intentionally claim as his own a procedure in the treatment of operation wounds which I, on two occasions—viz., in the "Journal of the American Medical Association" in 1884, and also in the "New York Medical Journal" in 1885—announced to the surgical profession, and which I have continuously

practiced since 1879. He has no more claim to priority in the method of treatment of wounds by hot water than he has to the invention of Corning's method of using cocaine, or to Sims's dilator.

The restorative powers exerted by hot water on the general circulation are also, to as great an extent, manifested on the local circulation of a part whose vitality is to a certain extent damaged by contused or contuso-lacerated wounds, as of the extremities, such as we often meet with in hospital practice among the employees of the numerous railroads which have their termini in our midst. Poiseuille has shown in his experiments on the web of a frog's foot that, if the part be covered with water at  $104^{\circ}$  F., the rapidity of the current in the capillaries is so much increased that we can hardly distinguish the form of the corpuscles. These injuries are usually sustained by the coupling of cars, and exhibit every variety of severity from simple rupture of the skin, with subcutaneous extravasation of blood, to a general crushing of the whole part into a homogeneous mass, for which the only remedy is amputation. For the treatment of every degree of injury except the last mentioned the limb is placed in a water-bath as hot as can be borne, and retained for a half-hour at a time. These baths are repeated three or four times a day. The part injured, during the interval, is wrapped in oakum wrung out of hot water, and covered with oiled silk. By this method many a limb has been saved which seemed damaged beyond recovery.

There seems to be a lack of appreciation on the part of some who have criticised and profess to have practiced the method under consideration. The late Professor Frank H. Hamilton, in a very able article on "The Art of Primary Union by Adhesion," published in the "Medical Record," January 2, 1886, says: "Dr. Varick recommends that the

water have a temperature slightly below the boiling point; this might do if one were to apply it by means of a sponge, and then only for an instant. . . . But if employed continuously or by irrigation through the nozzle of a tube, it ought not to exceed in temperature  $112^{\circ}$  or  $115^{\circ}$  F., or a temperature which may be easily borne by the hand." Dr. Hamilton evidently failed to appreciate the mode and object of the application advocated by me.

The application is always made with a clean sponge or sheet lint, and is kept in contact with the part for several minutes, or frequently renewed applications are made, until the changed appearance of the parts is observed as previously described.

Again, the object of a high temperature for the coagulation of the albuminous exudate on the surface of the wound is not recognized. The temporary glazing which occurs over the surface of a wound, as the oozing gradually and spontaneously ceases, must not be confounded with, nor considered as identical with, that produced by the application of hot water.

The glazing first named is nothing more than the result of coagulation of the sanguineous flow, having a surface of serum with an underlying clot, and due to fibrinous contraction and a process of desiccation. It is highly putrescible and easily washed away. As albumin at the temperature of the body is fluid, it possesses no protective power and partakes of the same liability to putrefaction as the other elements of the exudate. Hot water applied deprives it of its putrescible property, and it will exist unchanged for an indefinite period. I have kept a film of coagulated albumin, applied to a piece of fine linen, unchanged for a period of over four months, while the beef-tea, for which the albuminized linen was used as a cover, remained absolutely unchanged for a like period.

Before I used hot water, and used warm water instead, the effect invariably was to increase the outward flow, to keep patent the divided capillaries, and prevent the glazing of the parts; and many cases of sepsis followed. It seemed that the danger of contamination of the wound was enhanced by this method.

An amusing instance of failure to comprehend the principles involved in the subject under discussion occurred recently in a hospital not a thousand miles from New York. A surgeon, having occasion to perform an amputation at the lower part of the leg, and after ligating the vessels, was annoyed by a somewhat free oozing which he was unable to control. A gentleman present, who had on several occasions witnessed the hæmostatic effect of hot water in St. Francis and Jersey City Hospitals, suggested its use in this case. The hot water was brought and cold water added until it could be easily borne by the hand, then by means of a sponge it was applied for a moment several times. This proving ineffectual, the sponge, now saturated with water scarcely more than blood-warm, was held at a distance above the wound and the water allowed to trickle over the surface. It is needless to say this also failed. The verdict of the sapient operator was that "hot water is no good."

It would be impossible, even if it were desirable, to occupy the time of this assemblage with an enumeration of the various operations to which this method is applicable, and in which it is being constantly resorted to. I shall therefore content myself with a detail of major amputations performed by me since 1879, with a comparison of results obtained by me with that of others collected from statistics furnished by various authors in this country and Europe.

In the "International Encyclopædia of Surgery," vol. i, p. 626, in a table showing the comparative mortality of amputations for injury and disease, we find the following

percentage of mortality for major amputations by the authors enumerated :

	Cases.	Mortality. Per cent.
Malgaigne .....	560	53·3
Trélat.....	1,038	47·5
Golding Bird.....	859	31·8
Callender.....	358	20·6
Butlin and McCready .	416	18+
Holmes .....	500	31·6
Spencer .....	557	26·9
Chadwick.....	692	26+
Gorman .....	296	36·4
Varick .....	90	44·4
Norris and Morton .....	982	25—
Ashhurst .....	100	<del>28·28</del>
Total cases ...	6,448	
Mortality .....		32·9

In the London “Lancet,” April 9, 1887, we find at page 720 a paper entitled “The Result of Major Amputations treated Antiseptically in the Newcastle-on-Tyne Infirmary from April 1, 1878, to December 31, 1886,” by Mr. Frederick Page, as follows: Three hundred and eighty-two major amputations, with a mortality of 7·5.

At the University College Hospital, up to May, 1871, of 307 consecutive major amputations 79 proved fatal—a mortality of nearly 25 per cent.

Of 53 consecutive major amputations performed, by me and treated with hot water, I report 39 primary cases with 2 deaths, and 14 secondary cases with 1 death.

The fatal cases were as follows :

1. Fred. H., admitted to Jersey City Hospital, August 13, 1882, for compound comminuted fracture of the leg, for which amputation of the thigh at its lower third was done. There were several attacks of secondary hæmorrhage, and, although



the femoral artery was ligated in Searpa's space, he died of a sudden hæmorrhage on the 26th of the same month.

	Cases.	Recovered.	Died.
<i>Primary Cases.</i>			
Thigh .....	18	17	1
Leg .....	6	6	..
Arm .....	6	6	..
Shoulder joint .....	2	2	..
Right forearm, left thigh, with C. and L. wound of right foot .	1	..	1
<i>Secondary Cases.</i>			
Thigh .....	7	7	..
Leg .....	3	3	..
Arm.....	1	..	1
Hip joint.....	1	1	..
Forearm.....	2	2	..
Total.....	53	50	3

Mortality, 5.6 per cent.

2. Cornelius P., a private patient, suffered amputation of the arm on account of caries of the elbow joint. He progressed favorably from the time of operation, September 2, 1884, up to September 8th, when he died of a sudden attack of angina pectoris.

3. Noah R., admitted to St. Francis's Hospital, Jersey City, October 26, 1886, having sustained a compound comminuted fracture of the right forearm, a complicated, compound comminuted fracture of the left leg, and a contused and lacerated wound of the right foot. Amputation of the right arm and left thigh was done, and the remaining foot dressed with iodoform. He bore the operation well, and progressed favorably until November 1st, when symptoms of septicæmia developed, and he died November 7th, on the eleventh day after the injury. The operation wounds had united to nearly their whole extent by first intention, but the remaining foot had sloughed extensively, and was no doubt the source of his septic infection.

The case of P. might with propriety be excluded from the list of unsuccessful cases, as he died of a disease totally

unconnected with the amputation, and which he had suffered from on several occasions previously. Excluding this case, the rate of mortality would be reduced to 3·7.

Of the 53 cases recorded above, 44 were performed on account of railroad injuries. Thirty-four of the 53 cases reported by me occurred in St. Francis's Hospital, Jersey City, from August 12, 1879, to August 1, 1887, with the following result:

## HOT-WATER METHOD.

	Cases.	Recovered.	Died.
Thighs .....	16	16	..
Legs .....	4	4	..
Arms.....	5	5	..
Forearms .....	6	6	..
Hip joint.....	1	1	..
Shoulder joint .....	1	1	..
Right arm and left thigh .....	1	..	1
Total.....	34	33	1

Mortality, 2·9 + per cent.

During the same period, in the same hospital, in the same wards, and with the same hygienic surroundings, there were done 25 major amputations under Lister's method, with the following result:

## LISTER'S METHOD.

	Cases.	Recovered.	Died.
Thighs .....	10	6	4
Legs .....	3	3	..
Arms.....	7	6	1
Forearms .....	2	2	..
Shoulder joint .....	1	..	1
Both legs .....	2	1	1
Total.....	25	18	7

Mortality, 28 per cent.

Enough has been said to illustrate the therapeutie effects of hot water in surgical practice. It has stood the test of time and experience, and fulfilled every claim made for it. The results obtained in major operations under its use are unexcelled by any other method of antiseptis, while in the matter of major amputations it is unqualed. Simplicity and convenience are its characteristics.

The baseless fear of using water too hot may have deterred some from using the method, while others again look with disdain at the lack of display of the paraphernalia employed, the homespun nature of the appliances used, and there is absent that foreign glamour which to some presents an irresistible fascination. In it the gauze, protective, and carbolic spray find substitutes in a wad of oakum and grandmother's tea-kettle.

Since the preceding paper was written I have received the following letter from my friend, Dr. J. D. McGill, Surgeon-General of New Jersey, and one of the surgeons to St. Francis's and Jersey City Hospitals :

*Dr. T. R. Varick.*

DEAR DOCTOR: Inclosed you will find a record of eighteen capital amputations which have occurred in my practice during the last four or five years.

Six of these amputations were performed and subsequently treated according to Lister's method ; the remaining twelve (all amputations performed by me since March, 1885) were treated at the time of operation with hot water, after the method advised by yourself.

The subsequent treatment of these twelve cases has been to observe absolute cleanliness, and to insure perfect drainage.

The iodoform dressing has been the one employed.



## LISTER METHOD.

SITE OF OPERATION.	No. of cases.	Primary.	Secondary.	Recovered.	Died.
Thigh .....	1	1	..	1	..
Arm .....	2	2	..	1	1
Forearm .....	1	1	..	1	..
Leg ..	2	2	..	1	1
Total .....	6	6	..	4	2

The deaths were in both cases due to septicæmia.

## VARICK METHOD.

SITE OF OPERATION.	No. of cases.	Primary.	Secondary.	Recovered.	Died.
Thigh .....	3	2	1	3	..
Leg ..	4	4	..	4	..
Foot (Pirogoff's operation).....	1	..	1	1	..
Arm .....	2	1	1	2	..
Forearm .....	2	2	..	2	..
Total... ..	12	9	3	12	..

Yours respectfully,

J. D. MCGILL.





